Table 5-1. Technology Screening for Soil

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Potential for Retain for Further Evaluation
No Further Action	None	None	No further action to address contaminated soil.	Will not address the remedial objectives.	None	None	Yes as baseline for evaluation process
Institutional Controls	Access and Use Restrictions	Land Use Controls	Land use restriction (i.e., deed notice or restrictive covenant) is issued for properties located in the contaminated areas.	Will minimize direct exposure to the contaminants; therefore it will address remedial objectives partially. The current and future land use of the site is residential; residential, industrial, and commercial are potential uses for the Wilcox Process Area.	Implementable	Low	**Yes**
Containment	Consolidation and Capping	Clay Cap, Synthetic Membrane, or Chemical Sealant or Stabilizers	A cap is installed to cover the contaminated area to prevent direct exposure to the contamination. Different materials can be used for the cap and typical materials include clay, synthetic membranes, and chemical sealants or stabilizers. Contaminated soil can be consolidated in one area and capped.	Will prevent direct contact and exposure to the contaminated soil, although it does not remove the source of the contamination. It will address the relevant remedial objectives.	Implementable with commercially available equipment; potential worker and community exposure to dust; institutional controls will be required to protect the cap.	Medium	**Yes**
Removal	Excavation and Disposal	Excavation and Onsite Disposal	Contaminated soil is excavated and placed in a containment repository, which may consist of a bottom liner and a cap. Bottom liner may consist of, from bottom to top a impermeable liner, leachate collection layer, a protection layer overlain by excavated contaminated soil. A cap may consist of an impermeable layer, an infiltration collection layer, and soil cover and vegetation.	Will prevent direct contact and exposure to the contaminated soil by containing the contaminated materials in a repository. It will address the relevant remedial objectives.	Implementable with commercially available equipment. Potential worker and community exposure to dust during the construction, therefore dust controls will be required. Institutional controls are required to control the future land use and protect the integrity of the containment repository.	Medium	**Yes**
		Excavation and Offsite Disposal	Contaminated soil are excavated and transported to a permitted offsite facility for disposal.	Will remove the contaminated soil from the site. It will address the relevant remedial objectives.	Implementable. Potential worker and community exposure to dust during the construction and transportation for offsite disposal, therefore dust controls will be required.	Medium	**Yes**
Treatment	*In Situ* Physical, Chemical Treatment	Stabilization/Solidification	Reagents are mixed with soil to trap, treat, or immobilize contaminants. Treatment would stabilize and prevent contaminants leaching to the groundwater. Reagents may include Portland cement, bentonite, fly ash, organoclay, and activated carbon.	Will stabilize and reduce contaminants' migration, treated soil will remain onsite; administrative controls and land use restrictions will be required.	Implementable with commercially available equipment; treatability studies are required; and potential worker exposure to contaminants is present during mixing.	High. The contaminated soil is likely not hazardous, therefore the treatment is less cost effective compared to containment technologies.	No, due to high cost and lower benefit of treating the soil compared to containment technologies.
	Biological	Landfarming	Landfarming is used for the biological treatment of contaminated soil. It consists of spreading excavated contaminated soil either directly on the ground or on a membrane with an upper protective layer to prevent contaminants from migrating to the soil underneath and to the groundwater. Mixing or tilling of the contaminated soil is normally required to blend nutrients/amendments, and distribute moisture to promote biodegradation of the contaminants. Periodical watering is also required to provide optimal condition for microbial activities.	Landfarming is typically applicable to nonvolatile and semi-volatile compounds. Biodegradation of PAHs becomes more difficult as the number of aromatic rings increase. Therefore landfarming typically is not considered to be effective for treating PAHs that contain more than four rings, i.e., benzo(a)pyrene. It is not certain if landfarming will be effective for treating lead in soil with data currently available.	Implementable, however it may take a long period of time depending on biodegradation process in the soil.	Low	No due to ineffectiveness with inorganics
		Phytoremediation	Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation, phyto-extraction (also called phyto-accumulation), phyto-degradation, and phyto-stabilization.	Under controlled experimental settings, a variety of plants have been shown to remediate both lead and benzo(a)pyrene in surface soil. Treatability and pilot studies would be required to determine the effectiveness of phytoremediation at the site.	Technology is potentially implementable with pilot study. However, climate, site soil type, and / or lithology characteristics may not be conducive to needed plant/tree species. Limited species are effective with metals. It may also require a long period of time compared to other technologies depending on season and temperature.	Medium	No due to the concern on implementability

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General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Potential for Retain for Further Evaluation
Treatment	*Ex situ* Physical, Chemical Treatment	Excavation and Chemical Oxidation	Oxidizing agents (Fenton's reagent, permanganate, and ozone) are added into the excavated soil to promote abiotic destruction of contaminants.	Chemical oxidation will make lead and other metals become soluble, potentially causing mobilization of metals to groundwater.	Implementable	High. Can be cost prohibitive if the soil contains high organic matter.	No, due to the concern for mobilizing lead to groundwater and high cost.
		Excavation and Soil Mixing and Stabilization/Solidification	Reagents are mixed with excavated soil by a mechanical mixing device to trap, treat, or immobilize contaminants. Treated soil may be placed onsite for future applicable land use. Reagents may include Portland cement, bentonite, fly ash, organoclay, and activated carbon.	Will stabilize and reduce contaminants' migration, treated soil will remain onsite; administrative controls and land use restrictions will be required.	Implementable with commercially available equipment; treatability studies are required; and potential worker exposure to contaminants is present during excavation and mixing.	High. The contaminated soil is likely not hazardous, therefore the treatment is less cost effective compared to containment technologies.	No, due to high cost and lower benefit of treating the soil compared to containment technologies.
		Excavation and Soil Washing	Contaminants in soil are desorbed by using a solution of leaching agent, surfactant, pH-adjustment, or chelating agent to help remove the contaminants and fine materials on which the contaminants absorbed.	Will address the remedial objectives by removing the contaminants from the soil .	Complex process and produce a large quantity of process water that requires treatment. Acid reagent may be used to remove lead from soil, which increase the health and safety concern during the implementation.	High	No due to the concern on implementability.
		Excavation and Thermal Treatment	Heat is applied to the excavated soil to increase the volatility of the contaminants. An off-gas treatment will be used to treat the volatilized contaminants. *Ex situ* thermal treatment technologies include hot gas decontamination, incineration, thermal desorption, and vitrification, which use a high temperature to immobilize contaminants and produce non-toxic vitreous stabilized products.	Will destroy or remove and recover the contaminants, so it will address the remedial objectives.	Not readily implementable, treatability studies required; significant materials handling; specialized equipment and operators; extended construction/ treatment period (6-7 months); and viscous nature may require pre-treatment. If treated soil is placed onsite, beneficial use of the treated soil shall be studied for future land use, and institutional controls may be required.	High; not cost effective for the relatively low concentrations of the contaminants at the site.	No, due to complex implementation and cost.

Notes:
PAH = Polycyclic aromatic hydrocarbon